Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00116

Low-Cost Manufacturing for High-Temperature Polymer Matrix Composites

Technology

The National Aeronautics and Space Administration seeks to develop and transfer affordable processes for the manufacturing of hardware from high-temperature polymer matrix composites (PMC). Typical fabrication methods used with high-temperature PMC's are labor intensive and costly. More cost-effective fabrication techniques, such as resin transfer molding (RTM), cannot be used with these materials because of their high melt viscosities. Research at the Glenn Research Center and its contractors has been focused on the development of modified RTM processes that are amenable to use with high-temperature PMC's.

Benefit

- Reduced manufacturing costs for high-temperature PMC hardware

Commercial Applications

- Aerospace
- Transportation—engine components and exhaust systems
- Manufacturing—rolling and stamping

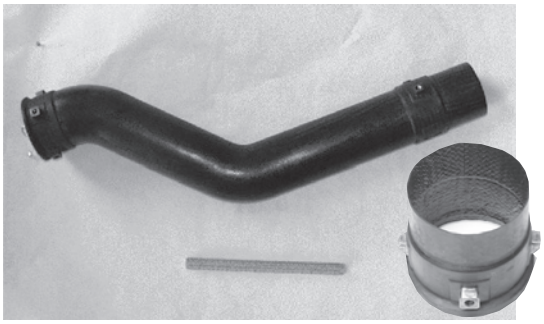
Technology Description

The use of high-temperature polymer matrix composites (PMC's) in aircraft engine applications can have a significant impact on reducing engine weight and improving performance and fuel efficiency. High-temperature PMC's, such as those based upon the NASA Glenn-developed PMR–15 polyimide matrix resin, have been used extensively in military applications where performance improvements are desired. However, in commercial engines cost is a primary driver and PMC components must be produced at a cost comparable to that of the metal components that they will replace.

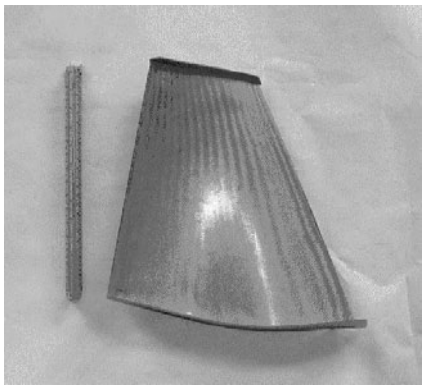
Current production methods used to manufacture high-temperature PMC components are fairly labor intensive. Techniques developed for PMC processing using resin transfer molding (RTM) are more efficient and less labor intensive. However, these methods are not suitable for use with high-temperature PMC's. RTM involves the infiltration of a fiber preform with molten resin. In order to process good quality parts via RTM, the resin must have a low enough melt viscosity (less than 1000 centipoise) and a sufficiently long pot-life to completely infiltrate the preform. While high-temperature polymers such as PMR–15 melt, the viscosity of the molten resin is too high to be successfully processed by RTM.

Under the Advanced Subsonic Technology program, researchers at Fiber Innovations, Inc., the General Electric Aircraft Engine Company, and the NASA Glenn Research Center have developed a modified RTM process that is suitable for use with high-temperature polymers. This process, designated solvent assisted resin transfer molding (saRTM), uses a solution of monomers, rather than the neat polymer, to infiltrate the fiber preform. Once the preform has been completely impregnated with resin solution, the solvent is removed under vacuum and the resulting part cured.

GE–90 center vent tube PMR–15 and AMB–21.



GE–90 HP cooling tube PMR–15, BIP–17S.



F–414 Front Frame AFR–700B

Figure 1.—Examples of high-temperature engine components that have been fabricated using saRTM.

The saRTM process is extremely versatile and has been demonstrated on a number of high-temperature addition-cured polyimides, such as PMR–15, AMB–21, and AFR–700B. A variety of components have been successfully fabricated using the saRTM process (fig. 1). Cost projections indicate that use of saRTM in place of hand layup can reduce manufacturing costs by 30 to 50 percent, depending upon the complexity of the component being fabricated.

Options for Commercialization

Substantial reductions in manufacturing costs can be achieved through the use of saRTM in place of traditional hand layup and autoclave or compression molding. The NASA Glenn Research Center is interested in developing partnerships to apply this low-cost manufacturing technology to other applications.

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Keywords

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